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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No.

INVENTOR(S)		
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Luc	PARENT	Chicoutimi, Quebec, Canada
Daniel	AUDET	Jonquiere, Quebec, Canada

☐ Additional inventors are being named on the ____ separately numbered sheets attached hereto

TITLE OF THE INVENTION (500 characters max)

SYSTEM FOR ONLINE MEASUREMENT OF ELECTRICAL CONDUCTIVITY OF CRUDE ANODE FOR ALUMINUM PRODUCTION

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ENCLOSED APPLICATION PARTS *(check all that apply)*

☒ Specification *Number of Pages*	2	☐ CD(s), Number	
☒ Drawing(s) *Number of Sheets*	1	☐ Other (specify)	
☐ Application Data Sheet, See 37 CFR 1.76			

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

		FILING FEE AMOUNT ($)
☐ Applicant claims small entity status. See 37 CFR 1.27		
☐ A check or money order is enclosed to cover the filing fee		
☒ The Director is hereby authorized to charge filing Fees or credit any overpayment to Deposit Account Number:	19-5113	$160.00
☐ Payment by credit card. Form PTO-2038 is attached		

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: _____

Respectfully submitted,

SIGNATURE _____ Date December 11, 2003

TYPED or PRINTED NAME Nicolas Pellemans REGISTRATION NO. *(If appropriate)* 38797

TELEPHONE (514) 847-4639 Docket Number: 16756-3USPR

SYSTEM FOR ONLINE MEASUREMENT OF ELECTRICAL CONDUCTIVITY OF CRUDE ANODE FOR ALUMINUM PRODUCTION

Aluminum metal is produced by the Hall-Heroult process in electrolytic cells. The cell is a recipient containing alumina dissolved into a mixture having a large content of molten cryolithe. The cathode is placed at the bottom of the cell and the anode at the top. Aluminum is produced when an electric current go through the cathode and the anode. The cathode is a permanent electrode that can last many years. The anode is not permanent and is consumed according to the aluminum production rate. A large part of the world production of aluminum is obtained from cells that use pre-baked anodes. Typically, pre-baked anodes are consumed in about 10 to 45 days, after which they have to be replaced. One cell can contain more than twenty anodes. An aluminum smelter that have many hundreds of cells, it is therefore necessary to produce and replace each day several hundreds of anodes.

Anodes are made from two basic materials: petroleum coke and pitch. Coke is a solid material that must be heated at high temperature before use. Pitch is a viscous and sticky material that binds solid particles of coke together and increases the surface of contact between particles. Having a larger surface of contact between particles increases the conductivity of the anode and consequently the aluminum production. However, adding a too high proportion of pitch create porosities that decrease the electrical conductivity of the anode. In another words, there is an optimum in pitch concentration.

A typical mixture must contain between 10 and 20 % (by weight) of pitch to get a product having a good cohesion and electrical conductivity. The percentage of pitch is adjusted according to the size distribution of coke particles. Higher content of pitch is necessary to bind particle of smaller diameter. When the target composition of the mixture is obtained, a pre-defined amount is pressed or vibrated into a mold having the form of the anode. The resulting product is a crude anode weighing between 500-1500 kg. Then, the crude anode must be baked to decompose the pitch into carbon in order to create a permanent binding between coke particles.

One of the major problems in anode production is the variation of the coke particle size. Particle size can vary from 100 microns to 5 cm. Moreover, the size distribution can vary from one batch to another. Since there is no instrument capable of determining the electrical conductivity of the anodes, they are always produced using the same proportion giving anodes of different electrical conductivity.

The present invention is a method to measure on-line and without contact the electrical conductivity of a crude anode. The method is based on the use of a time-varying magnetic field. The magnetic field is produced in a primary (emitting) coil made of a wire wound around a non-conducting hollow support. A secondary (receiving) coil is placed nearby, on that frame. The frame can be made of plastics, ceramics or any other material having a low electrical conductivity. The coils must be large enough to allow an anode to place inside the support.

Briefly stated, the primary (emitting) coil is used to generate an alternating magnetic field. The frequency of the magnetic field is between 100 and 10,000 hertz. The coils are arranged in such a way that the alternating magnetic field from the emitting coil induces a current in the receiving coil. The current varies when an anode is placed in the center of the support since the impedance of the receiving coil is affected by the electrical conductivity of the anode.

Physical parameters such as the impedance, the components of that impedance (that is the real (R) and imaginary (I) parts) or the "R to I" ratio can be used to measure the conductivity of the anode. Since each aluminum plant uses different technologies, coke and anode shape, it is necessary to calibrate the system to determine the range of variation of each parameter. The calibration is obtained by measuring between 3 and 10 anodes having known pitch percentages. This calibration can therefore be used to obtain the electrical conductivity of anodes that have been fabricated and the pitch concentration of next batches can then be corrected, if required, to reach the target value of conductivity.